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Listening to Mozart Does Not Enhance Backwards Digit Span Performance

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ABSTRACT

Rauscher, Shaw, and Ky recently reported that exposure to brief periods of music by Mozart produced a temporary increase in performance on tasks taken from the Stanford-Binet Intelligence Scale-IV. The present study examined whether this effect occurred in performance on a backwards digit span cask. In a within-subjects design 36 undergraduates were exposed to 10-min. periods of Mozart music, a recording of rain, or silence. After each stimulus period, undergraduates had three attempts to hear and recall different 9-digit strings in reverse order. No significant differences among treatment conditions were found. There was a significant effect of practice. Results are discussed in terms of the need to isolate the conditions responsible for production of the Mozart effect.

Rauscher, Shaw, and Ky (1993) reported that 36 undergraduates increased their mean spatial reasoning scores the equivalent of 8 or 9 IQ points on portions of the Stanford-Binet Intelligence Scale: Fourth Edition (Thorndike, Hagen, & Sattler, 1986) after listening to 10 min. of Mozart's Sonata for Two Pianos in D Major, K448 (hereafter labeled the "Mozart effect"). The Mozart effect was temporary, having disappeared within 10 to 15 minutes. Rauscher, Shaw, Levine, Ky, and Wright (1994) reported further that short periods of music education in school produced both a temporary effect, immediately after music training, and a permanent increase over a school year in performance by preschool children on the Object Assembly portion of the Wechsler Preschool and Primary Scale of Intelligence-Revised (Wechsler, 1989).

The hypothesis that musical experiences of short duration can have powerful effects on IQ scores on both a short-term and long-term basis is important for both practical and theoretical reasons. However, attempts to replicate the original report by Rauscher, *et al.* (1993) have been unsuccessful. Kenealy and Monsef (1994) were unable to produce a Mozart effect on performance using portions of the Stanford-Binet test, the Paper Folding and Cutting task and the Matrices task. Studies by Newman, Rosenbach, Burns, Latimer, Matocha, and Vogt (1995) and by Stough, Kerkin, Bates, and Mangan (1994) did not yield a Mozart effect when items from the Raven's Progressive Matrices (Raven, 1986) were the dependent measure. Carstens, Huskins, and Hounshell (1995) reported no Mozart effect when the dependent measure was the Revised Minnesota Paper Form Board Test, Form AA (Likert & Quasha, 1948).

Rauscher, Shaw, and Ky (1995) have reported a replication of the Mozart effect, using elaborations of the Stanford-Binet Paper Folding and Cutting task as the dependent measure. Further they specified that an appropriate task was one that involved not just spatial recognition but that it should incorporate spatial and temporal transformations. This observation was the basis for the dependent measure used here, a backwards digit span task. A backwards digit span task requires that a person listen to a string of digits and then reproduce them in reverse sequence. Theoretically, the backwards digit task is of interest as a spatial reasoning task because it requires rotation or transformation of the sequence (Carroll, 1993; Das, Kirby, & Jarman, 1979). Empirically, performance scores on this task correlate strongly with scores on memory for designs (Schofield & Ashman, 1986), performance with Raven's Progressive Matrices (Banken, 1985), and is a good predictor of performance with the Rod and Frame task (Haller, 1981). Right-hemisphere dysfunction reduces backwards digit span performance while left hemisphere dysfunction reduces forward digit span performance (Rapport, Webster, & Dutra, 1994; Rudel & Denckla, 1974), although this difference does not occur in all types of disorders (Gupta, Mahto, Tandon, & Singh, 1986).

The purpose of the experiment reported here was to examine whether a Mozart effect would be produced following the procedure of Rauscher, *et al.* (1993), using backwards digit span performance as the dependent measure.

METHOD

Participants
Thirty-six Euro-American upper-division university students (28 women and 8 men) from two sections of a psychology course volunteered and received course credit for their participation.

Apparatus
Two stimulus tapes of approximately 10 min. duration were created. One contained the Mozart Sonata for Two Pianos in D Major (K448) and the other contained the sound of a gentle rainstorm ("Spring Showers") from an environmental sounds recording. Sequences of digits were recorded on separate tapes for the digit span task. Tapes were played on a good quality portable system.

Procedure
The experiment took place in a room reserved for that purpose. The participant was told that the experiment concerned the effect of relaxation on recall and was instructed to sit in a large, comfortable, recliner chair. The chair faced away from the experimenter who operated the tape player which had been placed on a table by the left arm of the recliner chair.

Each participant listened in turn to the Mozart tape, the rainstorm tape, or sat quietly following the verbal instruction "to relax." The order of stimulus conditions was counterbalanced across participants using a Latin square design. Following exposure to a stimulus condition, each participant listened to three nine-digit sequences. Digits were presented on the tape at the rate of one every 2 sec. After each nine-digit sequence, the participant attempted to repeat that sequence in reverse order. The score recorded was the sum of number correct across the three sequences, the maximum score being 27. Each participant heard nine sequences of digits across the experimental session, three per stimulus condition. Digit sequences were created by a random-number generator and no sequence was repeated in a session to a participant. Three different units of digit sequences were created and assigned in a balanced fashion across participants.

The number of digits correctly recalled in reverse order was recorded for each subject for each condition. A correct recall was defined as the correct digit in the correct serial location. For example, if the original sequence was 7-5-3-1-9 and the recalled sequence was 9-1-3-4-7 then the score would be 4 correct. The Rauscher, *et al.* prediction is that the number of digits correctly reversed in recall should be enhanced in the Mozart condition relative to both the silence and the rainstorm condition.

RESULTS

Table 1 shows three descriptive measures of mean recall on the backwards digit span task. The headings under "Stimulus Condition" show mean performance as a function of the type of stimulus which immediately preceded the recall task. There was no difference over-all in mean recall as a

function of the preceding stimulus condition ($F_{2.70}$ = .03, P = .97). The outcomes of specific inferential contrasts were consistent with this observation, Music versus Rain (t_{35} =0.03, p=.98) and Music versus Silence (t_{35} =0.21, p= .83).

TABLE 1
MEAN SCORES ON BACKWARDS DIGIT SPAN

Condition	*M*	*SD*	*n*
Stimulus Condition			
Music	18.53	4.14	36
Rain	18.50	6.07	36
Silence	18.72	5.09	36
Order of Task			
First	15.64	4.70	36
Second	19.14	4.87	36
Third	20.97	4.29	36
First Stimulus			
Music	16.67	2.77	12
Rain	14.17	5.70	12
Silence	16.08	5.13	12

Note.—Maximum score = 27. Number of scores in comparison indicated by *n*.

The lack of differences in performance among stimulus conditions was not due to unsystematic variability. For example, a clear practice effect overall was observed ($F_{2.70}$ =21.92, p<.001). Although serial position was completely counterbalanced in stimulus presentation, we calculated performance as a function of serial position. The headings under "Order of Task" in Table 1 give mean recall as a function of the serial position of the stimulus condition. The data indicate that mean recall was improved by additional experience in the task. This observation is confirmed by inferential tests, First versus Second (t_{35}=4.24, p < .001) and Second versus Third (t_{35}=2.41, p= .02).

All three stimulus conditions *were* administered in a single session as was done by Rauscher, *et al.* (1993). Although the effect of music is supposed to be short-lived, it is possible that there was *some* carryover *effect* of music onto the other stimulus conditions or the reverse. Therefore we compared performances after the first stimulus condition only, when there would be no such effects. The headings under "First Stimulus" in Table 1 indicate recall following a stimulus condition presented first in the session. Over-all there was no significant difference among treatments ($F_{2.22}$ = 1.26, P = .30). The mean recall after music is not different from that after silence (t_{11}=0.38, p=.71). Although mean recall after the rainstorm condition was lower than after music, the difference was not statistically significant (t_{11} = 1.26, P =.23).

DISCUSSION

Exposure for 10 min. to a recording of the Mozart Sonata for Two Pianos in D Major (K448) was not followed by an enhancement in performance on a backwards digit span task, a task chosen because it required a temporally extended quasispatial solution as did the paper folding and cutting task. The lack of effect here is inconsistent with the findings of Rauscher, *et al.* (1993, 1994, 1995) but is consistent with reports from other laboratories (Carstens, *et al.,* 1995; Kenealy & Manse£, 1994; Newman, *et al., 1995;* Stough, *et al.,* 1994). This difference is made more puzzling by the observation that Rauscher, *et al.* have reported large effects in their studies while both Newman, *et al.* (1995) and Stough, *et al.* (1994) conclude confidently that there was no Mozart effect in their experiments. One explanation for the failure of this and other experiments to obtain a Mozart effect could be related to the use of different dependent measures. But different measures cannot be the entire explanation because Kenealy and Monsef (1994) did not obtain a Mozart effect even though they used a paper folding and cutting task as did Rauscher, *et al.* Kenealy and Monsef (1994) used silence as their control condition. Rideout and Laubach (1996) reported recently a positive effect with a paper folding and cutting task but they compared exposure to a Mozart sequence against exposure to a progressive relaxation tape only. The lack of a silence-only control condition means that one cannot state whether listening to Mozart improved performance or listening to the progressive relaxation tape reduced performance. Rauscher, *et al.* (1993) reported a Mozart effect relative to both silence and a relaxation-tape control condition.

There seems to be some important methodological difference between Rauscher, *et al.'s* work and that of other experimenters that has not yet been elucidated. The nature of this difference constitutes a puzzle since the experimental design seems straightforward. Rauscher, *et al.* (1994) emphasized the potential beneficial effects of increases in time and money allocated to music education in the grade-school curriculum. These practical considerations add to the importance of the solution of this scientific puzzle.

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